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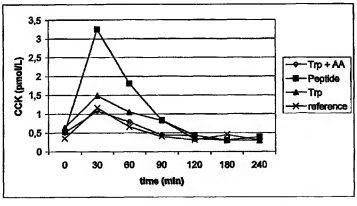
(54) Title: USE OF TRYPTOPHAN RICH PEPTIDES



(57) Abstract: Described is the novel use of peptides derived from whey protein hydrolysate as active ingredient in a medicament or as food ingredient for elevating the cholecystokinin level in the blood, and for preventing or treatment of overweight and/or obesity, in an animal, including human, in need thereof.

WO 2004/069265 A1

PATENT COOPERATION TREATY

PCT

REC'D 20 OCT 2003
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INTERNATIONAL SEARCH REPORT

30/12/2004

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
A03-40016/RKI		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/NL 03/ 00084	07/02/2003	

Applicant

CAMPINA B.V.

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 6 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [X] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the title,

[ ] the text is approved as submitted by the applicant.

[X] the text has been established by this Authority to read as follows:

USE OF TRYPTOPHAN RICH PEPTIDES

5. With regard to the **abstract**,

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

[X] as suggested by the applicant.

[ ] None of the figures.

[ ] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

USE OF TRYPTOPHAN RICH PEPTIDES

The invention relates to a novel use of peptides derived from a whey protein hydrolysate.

In the art, several attempts have been made to elevate the cholecystokinin (CCK) levels in the intestine, e.g. by providing specially designed nutritive agents that are said to stimulate the release of CCK. Such a nutritive agent is described in US patent application US2002/0119915, wherein a powder composition is disclosed, comprising proteins, fatty acids and a proteinase inhibitor, that is to be ingested before a meal to extend post meal satiety. The proteinase inhibitor was described to be critical for the stimulation of CCK release. Although whey protein could be used as protein source in the said composition, peptides derived from a whey protein hydrolysate were not disclosed. Moreover, the presence of a proteinase inhibitor would prevent the formation of a hydrolysate.

It has now been surprisingly found that peptides derived from a whey protein hydrolysate have a positive effect in elevating the CCK level in an animal, including humans, in particular in the blood. CCK is known to play an important role in the treatment and prevention of obesity and overweight, by mediating a satiety signal in the animal (see e.g. A. Stafleu, Leads in Life Sciences, 2002, (14) pp. 9-10).

Therefore, the invention provides a novel use of peptides, derived from a whey protein hydrolysate, as active ingredient in a medicament or as food ingredient for elevating the cholecystokinin level in the blood of an animal, including human, in need thereof, and also for preventing or treatment of overweight and/or obesity.

The term "peptides" is known in the art; herein the term relates to amino acid chains, preferably having a molecular weight of 500-5000 Dalton, more preferably between 1000-3000 Dalton. It is e.g. general knowledge that proteins can be fragmented by hydrolysis into peptides that consist of a small number of amino acids.

The peptides for use according to the present invention are obtained by hydrolysis of whey protein, more preferably by enzymatic cleavage of a whey protein. Hydrolysis and enzymatic cleavage of

proteins to obtain peptides, i.e. protein fragments, are known techniques in the art.

In a preferred embodiment, the peptides are prepared by cleaving the whey protein by one or more acid proteases or cysteine proteases, preferably chosen from the group, consisting of pepsin, papain or bromelain, or a mixture of two or more thereof. Preferably, the protein source is cleaved by pepsin, preferably at a pH of between 1,5-3,5, more preferably between 2-3.

The peptides are derived from whey protein. It is observed that whey proteins have a relatively high tryptophan content (about 1,8 w/w%). In a very attractive embodiment of the invention, the peptides are derived from whey protein isolate, preferably whey protein concentrate, most preferably from α-lactalbumin enriched whey protein concentrate (WPC) or α-lactalbumin enriched whey protein isolate (WPI). The terms "whey protein isolates" and "whey protein concentrates" are known in the field, see e.g. Walstra et al., 1999, Dairy Technology, ISBN 0-8247-0228-X. Whey protein concentrate is a whey protein product having 35-80 w/w% protein, whereas whey protein isolate has a protein content of 90 w/w% or higher. An example of WPC is Lacprodan 80 from ARLA, Denmark; an example of WPI is Bipro from Bio-isolates Ltd. α Lactalbumin enriched whey protein isolates and concentrates are derived from whey protein and have an elevated α-lactalbumin content. The α-lactalbumin content of αWPC may e.g. vary, depending on the preparation, between 20-80 w/w%, whereas the αlactalbumin content of normal WPC is about 12-18 w/w%. α-Lactalbumin has a high tryptophan content of about 5,8w/w%. A whey protein isolate containing about 60w/w% α-lactalbumin can be obtained from DMV International, the Netherlands, and is described in EP 0 604 684.

In a preferred use according to the invention, the peptides are obtained by an isolation method, the said isolation comprising the steps of:

a) providing an aqueous whey protein hydrolysate,

b) controlling the pH of the aequeous whey protein hydrolysate to 4,0-6,0, forming a peptide precipitate, and

c) isolation of the precipitated peptides.

As outlined above, the skilled person is aware of suitable conditions for performing hydrolysis reactions on the whey protein. The term "controlling" of the pH means that the pH should be adjusted or kept at the above described pH value during the precipitation of the peptides.

Isolation of the precipitated peptides can be done by methods that are known in the art. The precipitated peptides can e.g. be collected by centrifugation, decantation or filtration and the like. In order to obtain a long shelf life, the isolation preferably comprises a drying step. The skilled person is aware of suitable drying techniques. As will be shown in the examples it has been found that the precipitated peptides, are effective in elevating the CCK level and can be used against overweight and obesity.

Preferably, the precipitation is carried out at a temperature below 20°C. Below said temperature, the peptides have shown to precipitate very efficiently.

As outlined above, the aqueous peptide mixture, i.e. the whey protein hydrolysate is preferably prepared by enzymatic cleavage of whey protein, and more preferably, the whey protein is cleaved at acidic pH by one or more acid proteases or cysteine proteases, especially by one or more enzymes, chosen from the group, consisting of pepsine, rennin, acid fungal proteases, chymosin, papain, bromelain, chymopapain or ficin or mixtures of two or more thereof. By cleavage of whey protein by one or more of said acid proteases, especially pepsin at a pH between 1,5 and 3,5, preferably between 2-3, peptides having a hydrophobic nature are generated. It was found that from these peptide mixtures, the effective peptides could very efficiently be selectively isolated by controlling the pH to 4,0-6,0, preferably to around 5,0. In case the pH at the enzymatic cleavage was below 4,0, the pH was to be adjusted to 4,0-6,0 in order to precipitate the peptides. Preferably, the enzymatic activity is quenched by inactivation of the enzyme before the precipitation step. The skilled person will know how to inactivate the proteolytic enzyme. In case an enzyme is chosen having its pH optimum within the above mentioned pH range of 4,5-6,0, such as e.g. papaine or bromelaine, it will be possible to design the isolation method in such way that cleavage of the whey protein and precipitation of the peptides can occur simultaneously. Care has to be taken that the

precipitation is done at conditions wherein the hydrolysed peptides preferentially precipitate; otherwise, a precipitate of partial hydrolysed peptides may be obtained.

Preferably, the peptide mixture is desalted before the step of controlling the pH (step b). It has been found that a desalting step prior to the pH controlling step leads to an improved yield of precipitated peptides. Desalting is a known technique and can be done by e.g. nanofiltration, ultrafiltration or electrodialysis. Especially when the peptides are obtained by enzymatic cleavage, desalting the obtained peptide mixture leads to improved yields. Desalting is preferably carried out such that 50-95% of the salt present during the cleavage reaction is removed from the peptide mixture.

By the above-described isolation method, a peptide mixture can be obtained, that can advantageously be used in e.g. a food ingredient or a medicament for the elevation of CCK levels and against obesity and overweight.

The invention further relates to a method for elevating the cholecystokinin level in the blood of an animal, including human, in need thereof, comprising the step of administering to the animal an effective amount of peptides from a whey protein hydrolysate as described above. The administration can be performed according to methods, known in the art; the peptide mixture can be administered as a medicament, comprising a suitable carrier. The administration route can be any route known in the art, such as, but not limited to oral percutaneous route. The medicament can be in any known form, such in the form of pills, ointments, or injection fluids. The peptide mixture can also be administered as a powder or be incorporated in a food product.

The invention also relates to a method for preventing or treatment of overweight and/or obesity of an animal, including human, in need thereof, comprising the step of administering to the animal an effective amount of peptides from a whey protein hydrolysate as described above.

The invention will now be further illustrated by some non-limiting examples and a figure, wherein the mean CCK concentrations in plasma of human volunteers (in pmol/l, n=8) is shown at several time points after consumption of peptides according to the invention

(black squares), of amino acids including tryptophan (blank diamonds), of tryptophan as amino acid (black triangle) and of a reference substance (cross).

The percentages in the examples are weight percentages, unless indicated otherwise.

Example 1

Preparation of peptides derived from whey protein hydrolysate

A whey protein isolate solution containing 75% α-lactalbumin (Davisco) is dissolved in demineralised water, resulting in a solution comprising 2,8 w/w% dry solids and 2 w/w% α-lactalbumin. The pH is adjusted to 2.0 using 2M phosphoric acid. Hereafter the said mixture is heated to 50°C.

The hydrolytic reaction is started by adding 0.5% E/S pepsin (Merck, USA). E/S stands for the enzyme/substrate ratio. After 6 hours the reaction is stopped by incubating the reaction for 10 minutes at 90°C. Subsequently, the pH was raised to 5.0 and the temperature was lowered to 4°C. After storage of 20 hours at this temperature, the precipitated peptides are collected by decantation and centrifugation and subsequent freeze drying.

Tryptophan is determined using a specific technique based on total enzymatic hydrolysis (Garcia, S.E.; Baxter, J.H. (1992) Determination of tryptophan content in infant formulas and medical nutrition. *J. AOAC Int.* 75:1112-1119). The amino acids phenylalanine, tyrosine, leucine, isoleucine, valine and methionine are determined according EG guideline 98/64 (3-9-1998; publication L257/14-23 of 19-9-1998). Protein (81,1%) is determined using the standard Kjeldahl method (IDF-FIL 20A, 1986). The resulting product contains 8,5% tryptophan on product, and 10.4% on peptide.

A chemical and amino acid analysis is given in table 1.

Table 1

Chemical analysis (expressed on powder)		
Protein (Kjeldalh N*6.38)	81.1%	
Fat	3.7%	
Lactose	< 0.1%	
Ash (825°C)	4.8%	
Amino Acid Analysis		
Tryptophan on powder (Trp)	8.5%	
Trp/protein	10.4%	
Trp/LNAA	0.37	
(Large Neutral Amino Acids: Val, Tyr, Leu, Ile, Phe)		
Amino Acid Profile (per gram of protein):		
Alanine (Ala)	51.4	mg
Arginine (Arg)	7.3	mg
Aspartic acid (Asp)	96.8	mg
Cystine (Cys)	74.2	mg
Glutamic acid (Glu)	155.4	mg
Glycine (Gly)	14.9	mg
Histidine (His)	59.9	mg
Isoleucine (Ile)	25.3	mg
Leucine (Leu)	131.6	mg
Lysine (Lys)	109.6	mg
Methionine (Met)	4.9	mg
Phenylalanine (Phe)	55.4	mg
Proline (Pro)	63.0	mg
Serine (Ser)	47.6	mg
Threonine (Thr)	77.6	mg
Tryptophan (Trp)	104.3	mg
Tyrosine (Tyr)	22.4	mg
Valine (Val)	43.6	mg
Total:	1145.2	mg

Example 2

Preparation of peptides, derived from whey protein hydrolysate 2

A whey protein isolate (WPI), containing 60% α-lactalbumin (experimental product of DMV International, The Netherlands) is dissolved in an aqueous solution. The pH of the solution is adjusted using diluted phosphoric acid and heated to 45°C.
Hydrolysis is started by adding 2% pepsin (Merck, 2500 FIP-U/g) and carried out for 2 hours. The reaction is stopped by pasteurising the solution at 85°C for 10 minutes. Hereafter, the pH is raised to 5.5

and the solution is cooled to <15°C. After 10 hours, the precipitated peptides are collected using microfiltration. Typically, a membrane having a nominal molecular weight cut-off of 1 µm is used. The peptides are hereafter spray dried. The resulting product contains 9.3% tryptophan on peptide.

Example 3

Preparation of peptides, derived from whey protein hydrolysate 3

A whey protein solution similar to reference example 1 was hydrolysed with pepsin (American Laboratories, USA) using enzyme/substrate ratios (E/S) in w/w% of 0.25% and 0.75%. After 5 hours, the reaction was stopped by raising the pH to 5.2 using 1.0M NaOH and cooling the solution to <15°C.

The precipitated peptides were harvested after 16 hours by centrifugation.

Example 4

Preparation of peptides derived from whey protein hydrolysate 4

A 10% whey protein solution containing 45% α-lactalbumin (DMV International, The Netherlands) was dissolved in demineralised water. The pH was adjusted to 7.0 using 1M sodium hydroxide. Hereafter the solution was heated to 50°C.

The hydrolytic reaction was started by adding 2% ENZECO Bromelain 240 (Enzyme Development Corporation). After 21 hours the reaction was stopped by heating the solution to 85°C for 10 minutes. Subsequently, the peptide mixture was cooled to room temperature, the pH adjusted to 4.5 using phosphoric acid and the temperature is lowered to 10°C. After storage during 12 hours at this temperature, the precipitated peptides were collected by centrifugation and subsequent freeze drying.

The resulting tryptophan content of the peptides was 8%.

Example 5

Preparation of peptides derived from whey protein hydrolysate 5

100 l of a 5% whey protein isolate solution (Davisco) was prepared and then hydrolysed using 2% Pepsin. The solution was hydrolysed for

12 hours at pH 3.0. The reaction was stopped by heating the solution to 80°C for 30 minutes. Hereafter, the solution was ultrafiltrated on a pilot NF unit using Celgard NF-PES-10 membrane. The pH of the retentate was controlled at 3.0 and the solution filtered up to 200% diafiltration.

After desalting, the pH of the retentate was adjusted to 5.5 and the solution is cooled to <10°C to facilitate precipitation of the envisaged peptides. After 10 hours of storage, the precipitate was collected using centrifugation. Hereafter, the peptides were dried.

The tryptophan and peptide concentration in the sample was 9.5% and 91%, respectively.

Example 6

Increase of CCK levels on ingestion of tryptophan rich peptides

The experiment described below was performed in a double-blind, four period, randomised, cross-over, placebo controlled study.

Eight healthy human volunteers were divided into four groups of two, and were refrained from any food overnight. In the morning, the test persons obtained orange juice (containing 25 g glucose) and possibly a test substance, as follows:

Group 1: orange juice containing 5,91 g peptides as obtained in example 1 per single dose orange juice (200 ml)
Group 2: orange juice containing 500 mg pure tryptophan (Ajinomoto USA, Inc.)
Group 3: orange juice containing a mix of free amino acids in the identical composition and concentration as in the juice of group 1. The said amino acids were purchased from Ajinomoto USA, Inc.)
Group 4: orange juice without any test substance.

The experiment was repeated four times such, that all the eight volunteers eventually obtained aal the four test substances. During the four hours following the ingestion of the orange juice, blood was taken from the test persons at t=0, 30, 60 90, 120, 180 and 240 minutes after ingestion. CCK analysis was carried out using a

radio-immunoassay (RIA) kit of Euro-Diagnostica (cat nr. #RB302) according to the instructions of the manufacturer.

The results are shown in table 2 below and in figure 3, showing a maximum CCK level of 3.25 pmol/l at t=30 minutes after ingestion. The basal level in humans is normally about 1 pmol/l and increases to between 3 and 8 pmol/l after a meal (Becker et al., Am. J. Surg., 1984 (147) pp. 124-129). As the maximum level of CCK is gradually reached between 10 and 45 minutes after ingestion of a meal (Himeno, Am. J. Gastroenterol., 1983 (78) pp. 703-707), it is very well possible that the maximum CCK level is higher than 3.25 pmol/l, and occurring between t=0 and t=30 minutes. The increasing plasma levels with 2-4 pmol are deemed to be relevant in increasing perception of satiety.

TABLE 2

Mean CCK levels in plasma (in pmol/l, n=8)

CCK (pmol/L)	amino acids	Trp-peptide	Tryptophan	Control
0 minutes	0.51±0.60	0.53±0.65	0.64±0.78	0.35±0.15
30 minutes	1.08±0.87	3.25±1.48	1.49±1.04	1.16±1.31
60 minutes	0.79±0.86	1.81±0.90	1.05±1.06	0.66±0.67
90 minutes	0.44±0.29	0.83±0.89	0.83±0.84	0.40±0.18
120 minutes	0.43±0.38	0.43±0.36	0.34±0.11	0.31±0.04
180 minutes	0.30±0.00	0.30±0.00	0.30±0.00	0.45±0.43
240 minutes	0.30±0.00	0.39±0.25	0.30±0.00	0.30±0.00

CLAIMS

1. Use of peptides, derived form a whey protein hydrolysate as active ingredient in a medicament or as food ingredient for elevating the cholecystokinin level in the blood of an animal, including human, in need thereof.

2. Use of peptides, derived from a whey protein hydrolysate as active ingredient in a medicament or as food ingredient for preventing or treatment of overweight and/or obesity in an animal, including human, in need thereof.

3. Method according to any of the preceding claims, wherein the peptides are prepared by enzymatic cleavage of whey protein.

4. Method according to claim 3, wherein peptides are prepared by cleaving the whey protein by one or more acid proteases or cysteine proteases, preferably chosen from the group, consisting of pepsin, papain or bromelain, or a mixture of two or more thereof.

5. Method according to claim 4, wherein the whey protein is cleaved by pepsin at a pH of between 1,5-3,5, preferably between 2-3.

6. Use according to any of the preceding claims, wherein the peptides are derived from whey protein isolate.

7. Use according to any of the preceding claims 1-5, wherein the peptides are derived from whey protein concentrate.

8. Use according to any of the proceeding claims, wherein the peptides are derived from α-lactalbumin enriched whey protein.

9. Use according to any of the preceding claims, wherein the peptides are obtained by an isolation method, the said isolation method comprising the steps of:

a) providing an aqueous whey protein hydrolysate,

b) controlling the pH of the aqueous whey protein hydrolysate to 4,0-6,0, forming a peptide precipitate, and

c) isolation of the precipitated peptides.

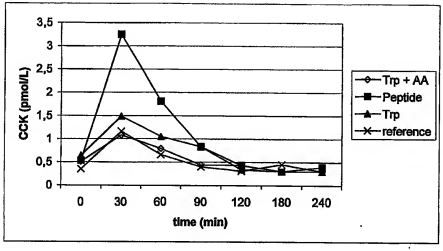
10. Use according to claim 9, wherein step a) is carried out at a temperature of below 20°C.

11. Use according to any of the preceding claims, wherein the peptides are desalted.

12. Method for elevating the cholecystokinin level in the blood of an animal, including human, in need thereof, comprising the step of administering to the animal an effective amount of peptides derived form a whey protein hydrolysate as defined in any of the claims 1-11.

13. Method for preventing or treatment of overweight and/or obesity of an animal, including human, in need thereof, comprising the step of administering to the animal an effective amount of a peptides derived from a whey protein hydrolysate as defined in any of the claims 1-11.

FIG. 1


3,5
3
2,5
2
1,5
1
0,5
0
CCK (pmol/L)
0
30
60
90
120
180
240
time (min)
Trp + AA
Peptide
Trp
reference

INTERNATIONAL SEARCH REPORT

PCT/NL 03/00084

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61K38/01 A23J3/34 A23L1/305 C12P21/06 C12S3/24
A61P3/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, BIOSIS, WPI Data, PAJ, MEDLINE, FSTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	AOYAMA T ET AL: "EFFECT OF SOY AND MILK WHEY PROTEIN ISOLATES AND THEIR HYDROLYSATES ON WEIGHT REDUCTION IN GENETICALLY OBESE MICE" BIOSCIENCE BIOTECHNOLOGY BIOCHEMISTRY, JAPAN SOC. FOR BIOSCIENCE, BIOTECHNOLOGY AND AGROCHEM. TOKYO, JP, vol. 64, no. 12, December 2000 (2000-12), pages 2594-2600, XP001109501 ISSN: 0916-8451	2,13
Y	the whole document	1-13
Y	WO 02 46210 A (CAMPINA MELKUNIE BV ;BOUMANS JOHANNES WILHELMUS LEO (NL); CAESSENS) 13 June 2002 (2002-06-13) page 5, line 36 -page 6, line 5; claims 1-13	1-13

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
9 October 2003	22/10/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ryckebosch, A

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	G.A. BRAY: "Reciprocal relation of food intake and sympathetic activity: experimental observations and clinical implications." INTERNATIONAL JOURNAL OF OBESITY, vol. 24, no. suppl. 2, 2000, pages S8-S17, XP002257146 page S8, abstract table 1	1-13
Y	DATABASE BIOSIS 'Online! BIOSCIENCES INFORMATION SERVICE, PHILADELPHIA, PA, US; 7 March 2001 (2001-03-07) MAHER TIMOTHY J ET AL: "The serotonin precursor 5-hydroxy-L-tryptophan decreases food intake in food-deprived and stressed rats" Database accession no. PREV200100243535 XP002257148 abstract & FASEB JOURNAL, vol. 15, no. 4, 7 March 2001 (2001-03-07), page A223 Annual Meeting of the Federation of American Societies for Experimental Biology on Experimental Biol;Orlando, Florida, USA; March 31-April 04, 2001 ISSN: 0892-6638	1-13
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-/-

INTERNATIONAL SEARCH REPORT

PCT/NL 03/00084

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 429 190 B1 (PORTMAN ROBERT) 6 August 2002 (2002-08-06) column 1, paragraph 1; claims column 5, line 66 -column 6, line 11	1-13

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

PCT/NL 03/00084

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

Although claims 12 and 13 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

PCT/NL 03/00084

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(54) **Title:** NOVEL NUTRACEUTICAL COMPOSITIONS

(57) **Abstract:** The present invention describes a composition which comprises a protein hydrolysate or a protein hydrolysate and one amino acid hydrolysate for the long term treatment or prevention of type 2 diabetes or pre-diabetes or metabolic syndrome or obesity.

NOVEL NUTRACEUTICAL COMPOSITIONS

Diabetes mellitus is a widespread chronic disease that hitherto has no cure. The incidence and prevalence of diabetes mellitus is increasing exponentially and it is among the most common metabolic disorders in developed and developing countries. Diabetes mellitus is a complex disease derived from multiple causative factors and characterized by impaired carbohydrate, protein and fat metabolism associated with a deficiency in insulin secretion and/or insulin resistance. This results in elevated fasting and postprandial serum glucose concentrations that lead to complications if left untreated. There are two major categories of the disease, insulin-dependent diabetes mellitus (IDDM, T1DM) and non-insulin-dependent diabetes mellitus (NIDDM, T2DM). T1DM = type 1 diabetes mellitus. T2DM = type 2 diabetes mellitus.

T1DM and T2DM diabetes are associated with hyperglycemia, hypercholesterolemia and hyperlipidemia. The absolute insulin deficiency and insensitivity to insulin in T1DM and T2DM, respectively, leads to a decrease in glucose utilization by the liver, muscle and the adipose tissue and to an increase in the blood glucose levels. Uncontrolled hyperglycemia is associated with increased and premature mortality due to an increased risk for microvascular and macrovascular diseases, including nephropathy, neuropathy, retinopathy, hypertension, stroke, and heart disease. Recent evidence showed that tight glycemic control is a major factor in the prevention of these complications in both T1DM and T2DM. Therefore, optimal glycemic control by drugs or therapeutic regimens is an important approach for the treatment of diabetes.

Long-term complications of patients with T2DM include cardiovascular disease, blindness, neuronal damage, renal failure and diabetic foot disease. A comprehensive overview about the long-term complications of T2DM is provided by the Center for Disease Control and Prevention (http://www.cdc.gov/diabetes/statistics/index.htm accessed on March 11, 2006) and therefore, the most common complications are only briefly mentioned here:

- Cardiovascular disease is the leading cause of death in subjects with diabetes, 70-80% of whom will eventually die from it.
- 73% of diabetics either have a blood pressure >130/80 mmHg or use anti-hypertensive medication.
- Diabetes is the leading cause of blindness in adults.
- As much as 50% of kidney failure cases are due to diabetes.

- More than 60% of subjects with diabetes display signs of neuropathy such as impaired sensation in the feet.
- The majority of non-traumatic lower limp amputations occur in diabetic subjects.
- Almost one third of people with diabetes have severe periodontal disease.
- Poorly controlled diabetes results in an increased rate of spontaneous abortions and can cause major birth defects.
-Diabetes during pregnancy can also result in excessively large babies, posing a risk for both mother and child.
- Other complications include diabetic ketoacidosis and hyperosmolar coma, which are acute life-threatening events.
- Finally, diabetes is also associated with an increased likelihood to acquire other diseases followed by increased mortality from those diseases, which include for example pneumonia and influenza.

Long-term glycemic control is determined by measuring glycosylated hemoglobin (HbA1c) levels. In subjects with chronically high blood glucose levels, the percentage of glycosylated hemoglobin is increased compared to subjects with normal blood glucose levels. The HbA1c concentration can be measured by two reference methods, mass spectroscopy and capillary electrophoresis. A reduction of HbA1c levels in subjects with diabetes suggests that the anti-diabetic therapy or treatment program was successful, e.g. enhanced glycemic control, during the previous 3 months.

Therapy of T2DM initially involves dietary and lifestyle changes, when these measures fail to maintain adequate glycemic control the patients are treated with oral hypoglycemic agents and/or exogenous insulin. The current oral pharmacological agents for the treatment of T2DM include those that increase insulin secretion (sulphonylurea agents), those that improve the action of insulin in the liver (biguanide agents), insulin-sensitizing agents (thiazolidinediones) and agents which act to inhibit the uptake of glucose (α-glucosidase inhibitors). However, currently available agents generally fail to maintain adequate glycemic control in the long term due to progressive deterioration of hyperglycemia, resulting from progressive loss of pancreatic cell function. The proportion of patients able to maintain target glycemia levels decreases markedly over time necessitating the administration of additional/alternative pharmacological agents. Furthermore, the drugs may have unwanted side effects and are associated with high primary and secondary failure rates. Finally, the use of hypoglycemic drugs may be effective in controlling blood glucose levels, but may not prevent all the complications of

diabetes. Thus, current methods of treatment for all types of diabetes mellitus fail to achieve the ideals of normoglycemia and the prevention of diabetic complications.

Therefore, although the therapies of choice in the treatment of T1DM and T2DM are based essentially on the administration of insulin and of oral hypoglycemic drugs, there is a need for a safe and effective nutritional supplement with minimal side effects for the treatment and prevention of diabetes. Many patients are interested in alternative therapies which could minimize the side effects associated with high-dose of drugs and yield additive clinical benefits. Patients with diabetes mellitus have a special interest in treatment considered as "natural" with mild anti-diabetic effects and without major side effects, which can be used as adjuvant treatment. T2DM is a progressive and chronic disease, which usually is not recognized until significant damage has occurred to the pancreatic cells responsible for producing insulin (β-cells of islets of Langerhans). Therefore, there is an increasing interest in the development of a dietary supplement that may be used to prevent β-cell damage and thus, the progression to overt T2DM in people at risk especially in elderly who are at high risk for developing T2DM. Protection of pancreatic β-cells may be achieved by decreasing blood glucose and/or lipid levels as glucose and lipids exert damaging effects on β-cells. The reduction of blood glucose levels can be achieved via different mechanisms, for example by enhancing insulin sensitivity and/or by reducing hepatic glucose production. The reduction of blood lipid levels can also be achieved via different mechanisms, for example by enhancing lipid oxidation and/or lipid storage. Another possible strategy to protect pancreatic β-cells would be to decrease oxidative stress. Oxidative stress also causes β-cell damage with subsequent loss of insulin secretion and progression to overt T2DM.

Therefore, T2DM is a complicated disease resulting from coexisting defects at multiple organ sites: resistance to insulin action in muscle and adipose tissues, defective pancreatic insulin secretion, unrestrained hepatic glucose production. Those defects are often associated with lipid abnormalities and endothelial dysfunction. Given the multiple pathophysiological lesions in T2DM, combination therapy is an attractive approach to its management.

The present invention relates to the use of a composition comprising a protein hydrolysate for the long term treatment or prevention of type 2 diabetes or pre-diabetes or metabolic syndrome or obesity or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity. Preferably the present invention relates to the use of a composition comprising a protein hydrolysate to

decrease 24-hour blood glucose levels in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to increase 24-hour insulin secretion in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to decrease glycosylated hemoglobin concentration (HbA1c) in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce the length of hyperglycaemic periods for subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce mortality in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity.

The present invention relates to the use of a composition comprising a protein hydrolysate as a nutraceutical, preferably a medicament, for the long term treatment or prevention of type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity. Preferably the present invention relates to the use of a composition comprising a protein hydrolysate as a nutraceutical, preferably a medicament, to decrease 24-hour blood glucose levels in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to increase 24-hour insulin secretion in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to decrease glycosylated hemoglobin concentration (HbA1c) in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce the length of hyperglycaemic periods for subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce mortality in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity.

The present invention relates to the use of a composition comprising a protein hydrolysate for the manufacture of a nutraceutical, preferably a medicament, for the long term treatment or prevention of type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity. Preferably the present invention relates to the use of a composition comprising a protein hydrolysate for the manufacture of a nutraceutical, preferably a medicament, to decrease 24-hour blood glucose levels in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to increase 24-hour insulin secretion in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to decrease glycosylated hemoglobin concentration

(HbA1c) in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce the length of hyperglycaemic periods for subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce mortality in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity.

Preferably, the composition which comprises hydrolysate also comprises leucine, preferably at least 70 wt% of the amino acids present in the composition is leucine and that less than 30 wt%, preferably less than 20 wt%, more preferably less than 10 wt% of other amino acids.

In general the protein hydrolysates are administered in an amount sufficient to administer to a subject a daily dosage of 0.01 g per kg body weight to about 3 g per kg body weight, in general the leucine is administered in an amount sufficient to administer to a subject a daily dosage of 0.005 g per kg body weight to about 1 g per kg body weight.

The present invention relates to novel nutraceutical compositions comprising protein hydrolysates or protein hydrolysates and leucine for the treatment or prevention of diabetes mellitus, or other conditions associated with impaired glucose tolerance such as metabolic syndrome and obesity. In another aspect the present invention relates to the use of such compositions as a nutritional supplement for the said treatment or prevention, e.g., as an additive to a multi-vitamin preparations comprising vitamins and minerals which are essential for the maintenance of normal metabolic function but are not synthesized in the body. In still another aspect, the invention relates to a method for the treatment of both type 1 and 2 diabetes mellitus and for the prevention of T2DM in those individuals with pre-diabetes, or impaired glucose tolerance (IGT), or obesity, or metabolic syndrome which comprises administering a protein hydrolysate or a protein hydrolysate and leucine to a subject in need of such treatment.

The compositions of the present invention are particularly intended for the treatment of both T1DM and T2DM and for the prevention of T2DM in those individuals with pre-diabetes, or impaired glucose tolerance (IGT), or metabolic syndrome, or obesity.

The present invention relates to a composition which comprises a protein hydrolysate or a protein hydrolysate and one (free) amino acid. Preferably the one amino acid is leucine. By one amino acid or one amino acid being leucine is understood herein

that of the amino acids present in the composition or in the ingredients which are intended for use according to the present invention, that at least 70 wt% of the amino acids present is one amino acid (such as leucine) and than less than 30 wt%, preferably less than 20 wt%, more preferably less than 10 wt% of other amino acids are present. The protein hydrolysate or the combination of a protein hydrolysate and one amino acid, preferably leucine, is advantageously used to decrease 24-hour blood glucose concentrations, preferably for type 2 diabetes or pre-diabetes.

Surprisingly, it is found that the protein hydrolysate or the protein hydrolysate combined with one amino acid can be used for type 2 diabetes or prediabetes, preferably to lower 24-hour glucose concentrations or to reduce the length of hyperglycemic periods or to decrease HbA1c levels.

The compositions comprising a combination of active ingredients, i.e. protein hydrolysate and leucine, synergistically reduce 24-hour glucose levels or the length of hyperglycemic periods or HbA1c levels.

The term nutraceutical as used herein denotes the usefulness in both the nutritional and pharmaceutical field of application. Thus, the novel nutraceutical compositions can find use as supplement to food and beverages, and as pharmaceutical formulations for enteral or parenteral applications, which may be solid formulations such as capsules or tablets, or liquid formulations, such as solutions or suspensions. As will be evident from the foregoing, the term nutraceutical composition also comprises food and beverages containing a protein hydrolysate or a protein hydrolysate and leucine as well as supplement compositions containing the aforesaid active ingredients.

By protein hydrolysate, hydrolysate or hydrolysed protein is meant the product that is formed by enzymatic hydrolysis of the protein, an enriched hydrolysate being a fraction of the protein hydrolysate for example enriched in selected peptides or wherein peptides or polypeptides have been removed from the hydrolysate. So an enriched hydrolysate is preferably a mixture of peptides (or a peptide mixture). The peptide mixture of the invention is therefore a mixture of at least two, preferably at least three, more preferably at least four tryptophane containing peptides. More preferably the mixture comprises a peptide population of which more than 50%, preferably even more than 60%, and most preferably more than 75% of the peptides present have a molecular weight below 500 Da. The protein hydrolysate used in the present invention has a DH of between 7 and 50, preferably a DH of between 10 and 40 and most preferably between 15 and 30.

A "peptide" or "oligopeptide" is defined herein as a chain of at least two amino acids that are linked through peptide bonds. The terms "peptide" and "oligopeptide" are considered synonymous (as is commonly recognized) and each term can be used interchangeably as the context requires. A "polypeptide" is defined herein as a chain containing more than 30 amino acid residues. All (oligo)peptide and polypeptide formulas or sequences herein are written from left to right in the direction from amino-terminus to carboxy-terminus, in accordance with common practice. A protein is defined as used herein as the non-hydrolyzed whey and casein protein. Moreover, protein can also mean hydrolyzed protein. By amino acid is generally meant free amino acid, which is thus not part of a peptide, polypeptide or protein.

A protein hydrolysate can be prepared by incubating a protein source with a single protease or a combination of proteases. Such proteases may be any type of protease including but not limited to endo-proteases, amino peptidases, carboxypeptidases or di- and tri-aminopeptidases.

The protein source can in principle be any protein source. A preferred source is casein or whey protein. A composition comprising whey protein according to the invention may be any composition comprising whey protein such as milk, cream and cheese whey. Whey protein preparations are commercially available in several forms such as whey protein concentrates (WPC) and whey protein isolates (WPI). Suitable protein substrates for hydrolysis also include whole milk, skimmed milk, acid casein, rennet casein, acid whey products or cheese whey products. Moreover, vegetable substrates like wheat gluten, milled barley and protein fractions obtained from, for example, soy, rice or corn are suitable substrates.

A protein hydrolysate can be prepared by contacting the protein substrate with one proteolytic enzyme or a combination of proteolytic enzymes. In case more than one protease is used, these proteases can be added to the protein substrate simultaneously. Alternatively, the proteases can be added to the protein in a predefined sequence. Optionally, the addition of the next protease is preceded by an inactivation of the protease or proteases that were used earlier in the hydrolysis process. Such inactivation may be achieved in various ways and the method of choice depends on the protease that has to be inactivated. Inactivation treatments include but are not limited to heat treatment and a change in pH. Alternatively, commercially available hydrolysates can be used.

The degree of hydrolysis (DH) of a protein substrate is an important parameter. The DH that can be achieved for protein hydrolysate and depends on a large number of parameters, which include but are not limited to the choice for a particular protease, the time that is allowed for the hydrolysis to proceed, the reaction conditions (pH, temperature, salt concentration etc) and the pre-treatment of the protein substrate before it is subjected to hydrolysis by the protease. The DH of the hydrolysate suitable for the process according to the invention may range form 5-50, preferably from 10-40, more preferably form 15-35. The hydrolysate may contain free amino acids. Methods to determine the DH are known to the experts in the field, e.g. the OPA-method described by Church et al. (Anal Biochem (1985) 146, 343). The degree of hydrolysis is the extent to which peptide bonds are broken by the enzymatic hydrolysis reaction.

The hydrolysates can be further processed in various ways, methods including but not limited to spray drying, ultrafiltration, freeze drying, vacuum drying. After drying, the dry material may be grinded and/or sieved in order to obtain fractions of a particular particle size range. Compounds may be added to the hydrolysate to facilitate drying or to influence the final characteristics of the dried hydrolysate such as its tendency to form lumps or its wettability.

In accordance with the present invention it has surprisingly been found that a composition which comprises a protein hydrolysate or a protein hydrolysate and leucine lower 24-hour glucose concentrations or to reduce the length of hyperglycemic periods or to decrease HbA1c levels. Therefore, compositions comprising a protein hydrolysate or a protein hydrolysate and leucine used to prevent or treat both T1DM and T2DM, and for the prevention of T2DM in those individuals with pre-diabetes, impaired glucose tolerance (IGT), or metabolic syndrome, or obesity.

The compositions identified above have been conceived because of their novel action. Owing to the sustained effects of the compositions, not only glycemic control is improved, but in some settings drug dosing can be decreased and adverse effects can be minimized. Thus, although the therapies of choice in the therapeutic treatment of T1DM and T2DM are based essentially on the administration of insulin and of oral hypoglycemic drugs, appropriate nutritional therapy is also of major importance for the successful treatment of diabetics.

A multi-vitamin and mineral supplement may be added to the nutraceutical compositions of the present invention to obtain an adequate amount of an essential nutrients missing in some diets. The multi-vitamin and mineral supplement may also be

useful for disease prevention and protection against nutritional losses and deficiencies due to lifestyle patterns and common inadequate dietary patterns sometimes observed in diabetes. Moreover, oxidant stress has been implicated in the development of insulin resistance. Reactive oxygen species may impair insulin stimulated glucose uptake by disturbing the insulin receptor signaling cascade. The control of oxidant stress with antioxidants such as α-tocopherol (vitamin E) ascorbic acid (vitamin C) may be of value in the treatment of diabetes. Therefore, the intake of a multi-vitamin supplement may be added to the above mentioned active substances to maintain a well balanced nutrition.

In a preferred aspect of the invention, the nutraceutical composition of the present invention contains a protein hydrolysate or a protein hydrolysate and leucine. Leucine suitably is present in the composition according to the invention in an amount to provide a daily dosage from about 0.001 g per kg body weight to about 1 g per kg body weight of the subject to which it is to be administered. A food or beverage suitably contains about 0.05 g per serving to about 50 g per serving of leucine. If the nutraceutical composition is a pharmaceutical formulation such formulation may contain leucine in an amount from about 0.001 g to about 1 g per dosage unit, e.g., per capsule or tablet, or from about 0.035 g per daily dose to about 70 g per daily dose of a liquid formulation. Protein hydrolysates suitably are present in the composition according to the invention in an amount to provide a daily dosage from about 0.01 g per kg body weight to about 3 g per kg body weight of the subject to which it is to be administered. A food or beverage suitably contains about 0.1 g per serving to about 100 g per serving of protein hydrolysates. If the nutraceutical composition is a pharmaceutical formulation such formulation may contain protein hydrolysates in an amount from about 0.01 g to about 5 g per dosage unit, e.g., per capsule or tablet, or from about 0.7 g per daily dose to about 210 g per daily dose of a liquid formulation.

Preferred nutraceutical compositions of the present invention comprise a protein hydrolysate or a protein hydrolysate and leucine

Dosage ranges (for a 70 kg person)

Protein hydrolysates: 0.07-210 g/day

Leucine: 0.005-70 g/day

The following Examples illustrate the invention further.

Pharmaceutical compositions may be prepared by conventional formulation procedures using the ingredients specified below:

EXAMPLES

Example 1

Soft gelatin capsule

Soft gelatin capsules are prepared by conventional procedures using ingredients specified below:

Active ingredients: Protein hydrolysate 0.3 g, leucine 0.1 g

Other ingredients: glycerol, water, gelatin, vegetable oil

Example 2

Hard gelatin capsule

Hard gelatin capsules are prepared by conventional procedures using ingredients specified below:

Active ingredients: Protein hydrolysate 0.7 g, leucine 0.3 g

Other ingredients:

Fillers: lactose or cellulose or cellulose derivatives q.s

Lubricant: magnesium stearate if necessary (0.5%)

Example 3

Tablet

Tablets are prepared by conventional procedures using ingredients specified below:

Active ingredients: Protein hydrolysate 0.8 g

Other ingredients: microcrystalline cellulose, silicone dioxide (SiO_2), magnesium stearate, crosscarmellose sodium.

B. Food items may be prepared by conventional procedures using ingredients specified below:

Example 4

Soft Drink with 30% juice

Typical serving: 240 ml

Active ingredient:

Protein hydrolysate is incorporated in this food item:

Protein hydrolysates: 1.5-15 g/ per serving

A Soft Drink Compound is prepared from the following ingredients:

I. Juice concentrates and water soluble flavors

1.1 Orange concentrate

	[g]
60.3 °Brix, 5.15% acidity	657.99
Lemon concentrate	
43.5 °Brix, 32.7% acidity	95.96
Orange flavor, water soluble	13.43
Apricot flavor, water soluble	6.71
Water	26.46

1.2 Color

β-Carotene 10% CWS	0.89
Water	67.65

1.3 Acid and Antioxidant

Ascorbic acid	4.11
Citric acid anhydrous	0.69
Water	43.18

1.4 Stabilizers

Pectin	0.20

Sodium benzoate	2.74
Water	65.60

1.5 Oil soluble flavors

Orange flavor, oil soluble	0.34
Orange oil distilled	0.34

1.6 Active ingredients

Active ingredient (this means the active ingredient mentioned above: protein hydrolysate) in the concentrations mentioned above.

Fruit juice concentrates and water soluble flavors are mixed without incorporation of air. The color is dissolved in deionized water. Ascorbic acid and citric acid is dissolved in water. Sodium benzoate is dissolved in water. The pectin is added under stirring and dissolved while boiling. The solution is cooled down. Orange oil and oil soluble flavors are premixed. The active ingredients as mentioned under 1.6 are dry mixed and then stirred preferably into the fruit juice concentrate mixture (1.1).

In order to prepare the soft drink compound all parts 3.1.1 to 3.1.6 are mixed together before homogenizing using a Turrax and then a high-pressure homogenizer (p_1 = 200 bar, p_2 = 50 bar).

II. A Bottling Syrup is prepared from the following ingredients:

	[g]
Softdrink compound	74.50
Water	50.00
Sugar syrup 60° Brix	150.00

The ingredients of the bottling syrup are mixed together. The bottling syrup is diluted with water to 1 l of ready to drink beverage.

Variations:

Instead of using sodium benzoate, the beverage may be pasteurized. The beverage may also be carbonized.

Example 5

Five Cereal Bread

Typical serving: 50 g

Active ingredient:

Protein hydrolysate is incorporated in this food item:

Protein hydrolysate: 1.5-15 g/ per serving

Other components:	[%]
Five cereal flour	56.8
Water	39.8
Yeast	2.3
Salt	1.1

The yeast is dissolved in a part of the water. All ingredients are mixed together to form a dough. Salt is added at the end of the kneading time. After fermentation, the dough is reworked and divided before a loaf is formed. Before baking, the surface of the loaf is brushed with water and sprinkled with flour.

Procedure:

Kneading:

Spiral kneading system	4 min 1st gear,5 min 2nd gear
Dough proofing:	60 min
Dough temperature:	22 - 24°C
Proofing time:	30 min

Baking:

Oven:	Dutch type oven
Baking temperature:	250/220°C
Baking time:	50 - 60 min

Example 6

Cookies Type Milano

Typical serving: 30 g

Active ingredients:

Protein hydrolysates and leucine are incorporated in this food item:

Protein hydrolysates: 0.9-9 g/ per serving

Leucine: 0.3-3 g/ per serving

Other components:	[g]
Wheat Flour, type 550	41.0
Sugar	20.5
Fat/Butter	20.5
Whole egg (liquid)	18.0
Lemon Flavor	q.s.
Baking agent	q.s.

All ingredients are added slowly under mixing to form a sweet short pastry.

Afterwards, the pastry is kept cool (4°C) for at least 2 hours before flattening the pastry to a thickness of approx. 5 mm. Pieces are cut out and brushed with egg yolk on the surface before baking.

Baking:

Oven: fan oven

Baking temperature: 180°C

Baking time: 15 min

Example 7

Toast

Typical serving: 100 g

Active ingredients:

Protein hydrolysate and leucine are incorporated in this food item:

Protein hydrolysate: 1.8-18 g/ per serving

Leucine: 0.6-6 g/ per serving

Other components:	[%]
Wheat Flour, type 550	55.4
Water	33.2
Yeast	2.8

Salt	1.1
Fat/Butter	5.5
Malt	0.6
Emulsifier baking agent	1.4

The yeast is dissolved in a part of the water. All ingredients are mixed together to form a dough. Salt is added at the end of the kneading time. Afterwards, the dough is reworked, divided and placed in a baking tin for fermentation. After baking, the loaf is unmoulded directly.

Procedure:

Kneading:

Spiral kneading system 5 - 6 min 1st gear; 3 - 4 min 2nd gear

Dough proofing: none

Dough temperature: 22 - 24°C

Proofing time: 40 min

Baking:

Oven: Dutch type oven

Baking temperature: 220°C

Baking time: 35 - 40 min

Example 8

Yoghurt - set type; 3.5% fat

Typical serving: 225 g

Active ingredients:

Protein hydrolysate is incorporated in this food item:

Protein hydrolysate: 1.5-15 g/ per serving

Other components:	[%]
Full fat milk (3.8% fat)	90.5
Skimmed milk powder 2.0	
Sugar	5.0

Culture	2.5

The milk is heated to 35°C before addition of milk powder, stabilizer, sugar and active ingredients. This mixture is heated to 65°C to dissolve all ingredients. Then the mixture is homogenized in a high-pressure homogenizer (p_1 = 150 bar, p_2 = 50 bar) at 65°C. This emulsion is then pasteurized at 80°C for 20 minutes. After cooling to 45°C natural yoghurt/culture is added and mixed. Then this mixture is filled into cups and fermented at 45°C for 3-4 hours until a pH of 4.3 is reached and then stored at 4°C.

Example 9

Yoghurt - stirred type; 3.5% fat

Typical serving: 225 g

Protein hydrolysate is incorporated in this food item:

Protein hydrolysates: 0.5-5 g/ per serving

Other components:	[%]
Full fat milk (3.8% fat)	90.2
Skimmed milk powder	2.0
Stabilizer	0.3
Sugar	5.0
Culture	2.5

The milk is heated to 35°C before addition of milk powder, stabilizer, sugar and active ingredients. This mixture is heated to 65°C to dissolve all ingredients before homogenization in a high-pressure homogenizer (p_1 = 150 bar, p_2 = 50 bar) at 65°C. This emulsion is then pasteurized at 80°C for 20 minutes. After cooling to 45°C natural yoghurt/culture is added and mixed, followed by fermentation at 45°C for 3-4 hours until a pH of 4.3 is reached. After cooling and stirring vigorously, the yoghurt is filled in cups and stored at 4°C.

Example 10

Ice cream; 8% fat

Typical serving: 85 g

Active ingredients:

Protein hydrolysate and leucine are incorporated in this food item:

Protein hydrolysates: 0.3-3 g/ per serving

Leucine: 0.1-1 g/ per serving

Other components:	[g]
Milk (3.7% fat)	600.00
Cream (35% fat)	166.00
Skim milk powder	49.10
Sugar	109.00
Glucose syrup 80%	70.00
Ice cream stabilizer	5.00
Flavor	q.s.
Color	q.s

Sugar, skim milk powder and stabilizer are added to the milk and cream, mixed and heated to 45°C. Then the color as stock solution and the glucose syrup is added as well as the active ingredients. The mix is heated up and pasteurized (20 min, 80°C). Then a homogenization step takes place. Afterwards the mix is cooled down under constant stirring and the flavor is added at 5°C. The mix maturated at 5°C during at least 4 h and then passed through an ice cream machine (overrun ca. 100%). The ice cream is filled into cups and stored at -20 to -30°C.

Example 11

Wine gums

Active ingredient:

Protein hydrolysate is incorporated in this food item:

Protein hydrolysate: 0.15-1.5 g/ per 30 g

Other components:	[g]
Gelatin 200 Bloom	80.0
Water I	125.0
Sugar crys.	290.0
Water II	120.0
Glucose-syrup DE 38 (carbohydrate source)	390.0
Citric acid	10.0
Flavor	2.0
Color	q.s.
Yield ca	1000.0

Disperse gelatin in water I, stir and dissolve by heating over a stream bath or using a microwave. Mix sugar with water II and bring to boiling until a clear solution is obtained. Remove from heat source. Mix with glucose syrup while dissolved sugar solution is still hot. Slowly add the gelatin solution. Let rest until foam on surface can be removed and 60-65°C is reached. Add flavor, citric acid and the color solution as well as active ingredients under stirring. Deposit into moulds printed into starch trays and let sit for at least 48 hours at RT. Remove starch powder and polish with oil or wax. Dry at RT and package into airtight pouches

Example 12

This example shows the effects of consumption of a drink containing a protein hydrolysate and leucine together with a mixed meal. The drink containing a protein hydrolysate and leucine or a placebo-drink without the protein hydrolysate and leucine was consumed 3 times during the day together with breakfast, lunch, and dinner. Eleven male subjects with long-term T2DM participated in 2 trials, in which a 24-hour blood glucose profile was determined.

To determine the 24-hour blood glucose profile a microdialysis fiber (Medica, Medolla, Italy) was inserted in the peri-umbilical region. The micro-fiber was subsequently connected to a portable continuous glucose-measuring device (CGMS;

GlucoDay®, A. Menarini Diagnostics, Firenze, Italy). Thereafter, subjects were provided with their diet and were allowed to return home and resume their normal daily activities. The following day the subjects consumed their designated meals, drinks and snacks at set time-points. After each main meal (i.e. breakfast, lunch and dinner) the subjects drank a bolus beverage (4 mL/kg) containing either the protein hydrolysate/leucine mixture (PRO) or flavored water (PLA). The subsequent day, subjects reported back to the laboratory where the CGMS was removed. CGMS data of the second day (from 0700 to 0700) were used for data analyses. The CGMS is an ambulant continuous glucose monitoring system based on the microdialysis technique and allows continuous glucose monitoring for a period of 48 h (13). A microdialysis fiber (Medica, Medolla, Italy) with an internal diameter of 0.17 mm and a cut-off weight of 18 kD was inserted in the peri-umbilical region, without anesthesia, using an 18-gauge Teflon catheter as a guide [Meyerhoff et al. Diabetologia (1992) 35, 1087]. The micro-fiber was subsequently connected to the portable continuous glucose-measuring device (GlucoDay®, A. Menarini Diagnostics, Firenze, Italy). The device consists of a peristaltic pump that pumps Dulbecco's solution at a rate of 10 µL/min through the microdialysis fiber. The subcutaneous interstitial fluid is taken up by the microdialysis fiber and is transported to the measuring cell. The glucose sensor, consisting of immobilized glucose oxidase measures the glucose concentration every minute and stores an average value every 3 min up until a 48 h period. The entire device, including the perfusion solution and the waste-bag, weighs about 250 g and is worn in a pouch under the subjects' clothes. The acquired data were downloaded from the device to a personal computer with GlucoDay® software (V3.0.5). Values reported by the CGMS were converted into glucose values using the capillary glucose measurements as calibration values. The efficacy and the accuracy of the CGMS device has been validated for both diabetic [Maran et al. Diabetes Care (2002) 25, 347; Wentholt et al. Diabetes Care (2005) 28, 2871] and non-diabetic subjects [Maran et al. Diabetes Metab Res Rev (2004) 20, S50; Poscia et al. Biosens Bioelectron (2003) 18, 891; Varalli et al. Biosens Bioelectron (2003) 18, 899]. To quantify and compare the prevalence of hyperglycemia between groups and trials, the amount of time during which glucose concentrations were above 10 mmol/L was calculated.

The 24-hour blood glucose responses were 5.2 ± 0.25 mol/24h/l in subjects consuming the placebo drink and 4.6 ± 0.3 mol/24h/l in subjects consuming the drink containing a protein hydrolysate and leucine ($P<0.05$). This means that the consumption

of 3 drinks containing a protein hydrolysate and leucine during the day resulted in a reduction of 24-hour blood glucose by 11.2%. It is an important goal for subjects with T2DM to reduce blood glucose levels during the day. The American Diabetes Association defined a blood glucose concentration below 10 mmol/l at random measurements throughout the day as one of the main goals of for subjects with T2DM. Random blood glucose concentrations above 10 mmol/l are known to be associated with increased mortality and more severe long-term complications in subjects with T2DM. If blood glucose concentrations exceed 10 mmol/l damage to many organs such as kidney, retina, and blood vessels occur. The longer blood glucose concentrations are above 10 mmol/l (hyperglycemic period) the greater is the damage exerted. Surprisingly, the consumption of a drink containing a protein hydrolysate and leucine resulted in a pronounced reduction in the length of hyperglycemic periods of 26% when compared to consumption of the placebo drink (see also table 1). We conclude that consumption of a protein hydrolysate and leucine significantly reduces 24-hour blood glucose concentrations and the length of the hyperglycemic periods in subjects with T2DM. Therefore, the invention is useful also for the reduction of mortality and for the prevention of long-term complications in subjects with type 2 diabetes or prediabetes or metabolic syndrome or obesity.

Table 1. Hyperglycaemic periods with blood glucose above 10 mmol/l (expressed in hours:minutes) of subjects consuming placebo or 0.3 g/kg protein hydrolysate + 0.1 g/kg leucine in a drink. The drink was provided 3 times during the day and was consumed together with a mixed meal (breakfast, lunch, dinner). Postprandial periods after breakfast, lunch and dinner were defined to be 4, 6 and 6 hours, respectively. * significantly different from placebo (P<0.05).

	Placebo	Protein hydrolysate	Delta %
24h	13:08	09:42 *	-26.1
Breakfast	03:20	03:00 *	-10.0
Lunch	04:26	03:39 *	-17.7
Dinner	02:16	02:17	0.7

CLAIMS

1. Use of a composition comprising a protein hydrolysate for the long term treatment or prevention of type 2 diabetes or pre-diabetes or metabolic syndrome or obesity or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, preferably to decrease 24-hour blood glucose levels in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to increase 24-hour insulin secretion in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to decrease glycosylated hemoglobin concentration (HbA1c) in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce the length of hyperglycaemic periods for subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce mortality in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity.

2. Use of a composition comprising a protein hydrolysate as a nutraceutical, preferably a medicament for the long term treatment or prevention of type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, preferably to decrease 24-hour blood glucose levels in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to increase 24-hour insulin secretion in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to decrease glycosylated hemoglobin concentration (HbA1c) in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce the length of hyperglycaemic periods for subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce mortality in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity.

3. Use of a composition comprising a protein hydrolysate for the manufacture of a nutraceutical, preferably a medicament for the long term treatment or prevention of type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic

syndrome or obesity, preferably to decrease 24-hour blood glucose levels in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to increase 24-hour insulin secretion in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to decrease glycosylated hemoglobin concentration (HbA1c) in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce the length of hyperglycaemic periods for subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, to reduce mortality in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity, or to prevent long-term complications in subjects with type 2 diabetes or pre-diabetes or metabolic syndrome or obesity.

4. Use according to anyone of claims 1 to 3 wherein the composition comprises leucine.

5. Use of claim 4 wherein at least 70 wt% of the amino acids present in the composition is leucine and that less than 30 wt%, preferably less than 20 wt%, more preferably less than 10 wt% of other amino acids.

6. Use according to anyone of claims 1 to 5 wherein protein hydrolysates are administered in an amount sufficient to administer to a subject a daily dosage of 0.01 g per kg body weight to about 3 g per kg body weight.

7. Use according to anyone of claims 1 to 6 wherein leucine is administered in an amount sufficient to administer to a subject a daily dosage of 0.005 g per kg body weight to about 1 g per kg body weight.

8. Use according to anyone of claims 1 to 7 wherein the hydrolysate or hydrolysate and leucine is used in the form of a food, beverage or a supplement composition for a food or beverage or in an pharmaceutically acceptable dosage form.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/053559

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23L1/305 A61K38/01 A61K31/198 A61P3/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A23L A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, FSTA, MEDLINE, BIOSIS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LOON VAN L J C ET AL: "AMINO ACID INGESTION STRONGLY ENHANCES INSULIN SECRETION IN PATIENTS WITH LONG-TERM TYPE 2 DIABETES" DIABETES CARE, AMERICAN DIABETES ASSOCIATION, ALEXANDRIA, VA, US, vol. 26, no. 3, March 2003 (2003-03), pages 625-630, XP009019276 ISSN: 0149-5992 the whole document -/--	1-21

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 June 2007	03/07/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Loher, Florian

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2004/022083 A (DSM IP ASSETS B.V; VAN DER HEYDEN, LUCAS, CYRIL, GERARD; VAN LOON, LUC) 18 March 2004 (2004-03-18) page 6, lines 13-23 page 7, line 17 - page 8, line 10 page 11, line 17 - page 12,. line 15 page 12, line 26 - page 13, line 6 page 19, lines 1-11 claims 1-3,12-18	1-21
X	VAN LOON LJC, SARIS WHM, VERHAGEN H, WAGENMAKERS AJM: "Plasma insulin responses after ingestion of different amino acid or protein mixtures with carbohydrate" AM. J. CLIN. NUTR., vol. 72, 2000, pages 96-105, XP002321922 table 1 figures 2-4 pages 103-104	1-21
X	VAN LOON LJC, KRUIJSHOOP M, VERHAGEN H, SARIS WHM, WAGENMAKERS AJM: "Ingestion of protein hydrolysate and amino acid-carbohydrate mixtures increases postexercise plasma insulin responses in men" J. NUTR., vol. 130, 2000, pages 2508-2513, XP002321923 page 2509, column 1, paragraph 2 page 2509, column 2, paragraph 2 figures 2,3 page 2512, column 2, paragraph 2	1-21
P,X	WO 2006/077202 A (DSM IP ASSETS B.V; WOLFRAM, SWEN; LOON VAN, LUCAS JOHANNES CORNELIS) 27 July 2006 (2006-07-27) the whole document	1-21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2007/053559

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

Although claims 1, 2 and 4-8 are directed to a method of treatment of the human/animal body (Article 52(4) EPC), the search has been carried out and based on the alleged effects of the composition.

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2007/053559

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004022083 A	18-03-2004	AU 2003264256 A1	29-03-2004
		JP 2006502154 T	19-01-2006
		US 2005271744 A1	08-12-2005
WO 2006077202 A	27-07-2006	NONE	